APPENDIX 4 – BASIS OF SCIENCE, SUPPORTING SCIENTIFIC LITERATURE

Maintaining or Restoring Old Growth Structure

Based on landscape and stand level fire suppression analyses, several authors advocate use of harvest and prescribed fire to restore old growth stand conditions to pre-1900 status.

In 1984, Habeck (1990) analyzed pre-1900 stand structure in a set of small remnant old-growth ponderosa pine – western larch groves in Patty Canyon on the Lolo National Forest. Because none of the selected stands showed evidence of previous logging, Habeck was able to compare historic stand structure with current structure. His study showed the stands to contain a significantly higher number of trees per acre than they did prior to 1900.

Habeck's study mapped and recorded the diameter and species of all trees greater than 1 inch dbh on south slopes (warm, dry) and north aspects (cool, moist). Translating the plot data, Habeck determined that south slopes would have contained an estimated pre-1900 tree density of 13 trees per acre. North slopes would have contained approximately 27 trees per acre. Interspersed smaller trees would have averaged 25 per acre on south slopes, and 43 per acre on north slopes, pre-1900. Thus, south slopes sites may have supported a total of 37 trees per acre, and north slopes may have supported about 70 trees per acre. At the time of the 1984 study, Habeck measured over 302 trees per acre (>3" dbh) on south slopes, and an estimated 211 trees per acre (>3" dbh) on north slopes. Numerous invading Douglas-fir and ponderosa pine seedlings below 3 inches dbh brought average stem diameters to over 500 trees per acre.

Habeck's study validated other successional prediction models for western Montana pine-larch forests that discussed the consequences of fire suppression in old growth stands (Arno 1988, Keane et al 1990). Habeck's study included recommendations for the use of more, not less, prescribed fire in combination with other silvicultural treatments to maintain or restore old growth forest conditions. In his study, Habeck warned that *"without careful planning, the remaining old-growth pine-larch populations in Pattee Canyon and perhaps similar old growth remnants in western Montana may not survive over the long term."*

In another study on the Lolo National Forest, Arno and others (1995 and 1997) examined eleven old growth stands across eight locations which had historically experienced frequent low-intensity and mixed-severity fires. They found that the structure and composition of old growth ponderosa pine and western larch had been dramatically altered by past fire exclusion and early-day logging. Current fire intervals were determined to be three times the pre-1900 mean fire interval and two times the maximum fire interval detected prior to 1900. Stand basal area (square feet per acre) had nearly doubled since 1900. Stand Density Index had increased by over 2 times, largely as the result of the development of thick Douglas-fir understories. In these same stands, the large overstory pine and larch had declined by 10 percent. Arno *et al* also observed thinning of foliage, infections of dwarf mistletoe, advanced bole rot, and reduced radial growth in the overstory ponderosa pine and larch; all indicators of tree stress related to overstocking.

Arno *et al's* study described several challenges in restoring historic old growth conditions to these stands including dealing with the radical alterations that had occurred to stand structure, live and dead fuels, and the shift of seed sources in favor of shade tolerant conifers. Their study concluded that to restore fire to maintain old growth conditions would first require the silvicultural removal of understory trees and some overstory trees. Arno *et al* warned that the application of fire without prior removal of some trees would be difficult since the burn intensity would likely damage the stressed overstory trees. Because of high fuel loads, a stand replacement fire today (unlike those that would have historically occurred) would likely result in significantly less natural regeneration of ponderosa pine because of the depleted seed source.

In a review of old growth management on Montana School Trust Lands, Pfister and others (2000) described two conditions in which tree harvesting was appropriate for old growth restoration. First, when initial restoration cutting treatments appeared to be necessary to restore old growth stands historically sustained by relatively low- to mixed-intensity fire (removal of understory trees). Second, when increased densification had occurred in the overstory of some old growth stands in the absence of low intensity fire (removal of some overstory trees). In their second example, Pfister *et al* explained that overstory removal would also be necessary in some instances in order to regenerate shade-intolerant species which had declined within old growth stands because of fire suppression or removal of seed sources. Pfister *et al* discussed how prescribed burning may be used to maintain old growth stands once initial restoration cutting has occurred. They also described how thinning could be used in second-growth western larch or Douglas-fir to accelerate large tree development, and thus accelerate stand evolution toward old growth status.

The Montana School Trust Lands Review acknowledged the benefits of old growth treatments including the increased uptake of nutrients and water, and increases in leaf nitrogen content, leaf toughness, growth increment, and resin flow. Collectively, the chemical, structural and physiological effects of old growth silvicultural treatments limit the severity of biotic (western pine beetle) and abiotic (fire) disturbance processes to levels that promote stand sustainability, rather than replacement.

In another study of low-severity and variable-severity models of fire and forest structure in western Montana and Colorado ponderosa pine and ponderosa pine – Douglas-fir forests, Baker et al (2006) concluded that an appropriate action for ecological restoration could include a mixture of passive and active approaches. They agreed that reintroduction of both low-severity surface fires and high-severity fires may also be feasible under some circumstances. However, unlike other authors, they felt that little or no restoration was necessary in undisturbed mature forests. They advocated that only in forests previously disturbed by logging or grazing should an active approach of thinning young stands combined with the protection of old trees be used to enhance structures typical of later stages of development. Baker *et al* asserted that the majority of low-severity model forests in Montana and Colorado are located in valley bottoms outside of National Forest jurisdiction, and that the mixed-severity model, which included thickets of shade-tolerant species in the understory of mature ponderosa pine – Douglas-fir forest, is more representative of the low to mid-elevation Forest Service lands. Baker cautioned against the widespread conversion of dense mature stands into sparse open woodlands based on the false premise that surface fires previously maintained tree populations at low densities across large areas of the National Forest.

Kolb *et al's* (2007 in press) review of old-growth ponderosa pine forests also concluded that thinning and burning treatments are in order to restore natural fire regimes. Like Baker *et al* (2006), Kolb cautioned that disturbance associated with restoration treatments could create additional regeneration, thus causing an endless, costly cycle of thinning that does not restore the forest. This concern, however could be ameliorated, as suggested by Pfister *et al* (2000). In their review of school trust lands, Pfister and others suggested that prescribed burning could be sufficient to maintain old growth stands once stand composition had been addressed through initial restoration cutting. Initially, harvest treatments would be needed to minimize mortality of desired old growth structure (Arno 1997). Fiedler and others (2007) acknowledged that future maintenance costs could be reduced by maximizing acreage and geographical juxtaposition of initial restoration treatments.

Effectiveness of Silvicultural Treatments on Maintaining or Restoring Stand Structure

Post treatment studies conclude that silvicultural treatments can be effective in maintaining or restoring old growth.

In 2002, Chadwick completed a silvicultural case study that evaluated the Lolo National Forest's old growth strategy. Chadwick also assessed old growth maintenance treatments implemented under the Sawmill Cyr Project on the Ninemile Ranger District. The Sawmill Cyr treatments varied in the retention of overstory from 60 to 80 square feet per acre, up to 120 square feet per acre. The results were restoration of open, park-like stands of ponderosa pine with some western larch. Chadwick concluded that thru a combination of treatments (harvest and underburning), the Forest was effective at meeting its Forest Plan objectives for maintaining or restoring old growth (Management Area 21) stand structure. Because tree removal (harvest) was used along with burning, mortality of the residual stand was mostly kept within prescription (10%). As Arno (1997) predicted, Chadwick's evaluation found that harvest along with prescribed burning was necessary to avoid damage to desired overstory trees.

In a second silvicultural case study of the Tola Timber Sale, Shotzberger (2003) found the Idaho Panhandle National Forest's (IPNF) treatments capable of meeting old growth restoration objectives. In this study, the IPNF used a combination of methods, including salvage of dead and dying trees, commercial thinning, grapple piling, and underburning to emulate historic stand structure, composition, and age class diversity. Shotzberger found that, initially, the treatments did not fully address the desirable composition of the site, which should have included a higher percentage of ponderosa pine and western larch. The treatments also did not account for long term mortality of old growth Douglas-fir from root disease. Shotzberger's study, however, concluded that the end results of the treatments would be beneficial in terms of maintaining old growth attributes. The results of the treatments were found to accelerate the trajectory of the stand to meeting old growth objectives as defined by Green et al (1992).

The physiological response of restoration cutting and burning in old growth stands was closely examined in a six year study in the Grant Creek drainage on the Lolo National Forest (Sala and Callaway 2004). The results of the Grant Creek study indicate that vegetation management can be used to improve old growth stand vigor. By reducing competition of understory Douglas-fir, old growth stands may be less susceptible to pathogen infection (insects and disease) because of limited availability of resources such as water and nitrogen (Kolb et al 1998, 2007). The Grant Creek study compared the effectiveness of several management treatments designed to restore old growth ponderosa pine and western larch stands to densities more typical of presettlement conditions. Five restoration treatments were examined, including: 1) control, 2) removal of understory Douglas-fir followed by pile burning, 3) removal of understory Douglas-fir followed by broadcast burning, 4) removal of some competing overstory trees and removal of understory Douglas-fir trees followed by pile burning, and 5) the removal of some competing overstory trees and removal of understory Douglas-fir trees followed by broadcast burning.

The Grant Creek study confirmed that old growth restoration treatments result in increased foliage and branch production, short term nitrogen intake, and wood radial growth rate and water use. Overall, differences between the restoration treatments were relatively small suggesting that amelioration of old growth tree function and growth is primarily accomplished by the removal of the vigorous Douglas-fir understory without necessarily involving prescribed fire. The authors however, acknowledged that the ecological role of fire extends much beyond its effect on tree function. Their results also suggest that additional thinning of the overstory may have additional positive effects on western larch tree function. The findings of this study are similar to other studies which examined physiological responses of old growth restoration treatments (Wallin 2004, Stone 1999, Kolb *et al* 2007).

Sala and Callaway's (2004) study findings on the Lolo National Forest were duplicated in a similar study on the Bitterroot National Forest's Lick Creek Experimental Area (Sala et al 2005).

In another study conducted in eastern British Columbia, Hawe and Delong (1997) concluded that old growth structure can be maintained through use of harvest and prescribed burn treatments. In their study, managers identified that the East Kootenay Trench Ecoregion contained several biogeoclimatic subzones with less than 5% old growth, considerably less than the 10% recommended by their Protected Area Strategy (PAS). Forest managers of the Cranbrook Forest District recognized that simply deferring or preserving old stands would not ensure the maintenance of true old growth conditions. In 1996, they conducted a trial and case study which modified stocking levels, species composition, and the forest floor to approximate pre-settlement stand conditions. Cutting specifications developed for the trial removed most of the excess smaller-diameter Douglas-fir stems from the stand. All ponderosa pine and Douglas-fir greater than 14 inches dbh, and larch greater than 7 inches dbh were retained. In addition, small thickets of regeneration were preserved over approximately 5% of the treatment area in a "skipped" pattern. Post harvest and burn monitoring conducted by Hawe and Delong, indicated that most old growth restoration objectives were met. In their case study, actual residual stand conditions were slightly different from target conditions (higher unmerchantable stems/acre). The researchers concluded that subsequent prescribed burning treatments were expected to kill most of this unmerchantable understory and any new regeneration that established in the next 20-year period.

Species Monitoring

Until now, the Forest has relied upon a variety of monitoring measures to predict the effects that its vegetation treatments may have on old growth associates. In addition to Forest sampling, and regional population monitoring (Northern Region Landbird Monitoring Program- NRLMP), the Forest has relied on a proxy, or "habitat association" approach, relating forest structural conditions to known habitat requirements to fulfill the question of whether old growth associates needs are met.

The "proxy" approach has, however, come under close scrutiny (Ecology Ctr., F.3d), and its potential effectiveness at displaying the relationships between species and habitat, or more specifically cover type which does not apply to this study, has been recently questioned (Cushman et al 2008).

A combination of the two methods, as the Forest currently uses, is most applicable. Hutto and Young (2002) discuss the benefits of relying upon a combination of short- and long-term population monitoring along with habitat associations. They indicate that a program that relies entirely on the monitoring of populations will always be reactive. They state that while population monitoring is necessary to identify changes in populations, habitat association information can be more effective at predicting those changes. Hutto and Young (2002) point to how habitat relationships have been effective at helping Region 1 alter its post fire salvage logging. Today, salvage logging is significantly less than it was a decade ago because of a better understanding of habitat needs of certain species that rely upon the post-fire landscape.

Unfortunately, whereas habitat relationships can be helpful at predicting population information, it is often difficult to relate species needs to any one particular forest condition. Rather, most species use a variety of habitat conditions that may be optimal at some particular spatial relationship, selecting across a wide geography for conditions suitable to various activities, such as foraging, roosting, and nesting. In other cases, species may be adapted to a fairly narrow band of habitat, with internal diversity that is not often mapped at the broader landscape scale.

Recent studies statistically show that the northern goshawk, pileated woodpecker, and flammulated owl use large landscapes. All three species integrate a diversity of forested and non-forested vegetation types over a variety of spatial scales to meet their life cycle needs. No literature suggests that these species exclusively require, or *"depend"* on old growth forests for their survival.

Samson's (2006) *Conservation Assessment of the Northern Goshawk, Black-backed Woodpecker, Flammulated Owl, and Pileated Woodpecker in the Northern Region*, provides a thorough compilation of available research and literature of habitat needs and potential effects of habitat management. According to this assessment, short-term viability of all four species (three of which are assessed in this study) is not an issue.

For the northern goshawk, Samson found no scientific evidence to indicate that their numbers are decreasing. He found that the extent and connectivity of habitat has actually increased since European settlement and habitat is well-distributed and abundant. Furthermore, Samson found that the current level of timber harvest of the forested landscape is insignificant, and suppression of natural ecological processes (fire) has increased and continues to increase the amount of northern goshawk habitat.

In his assessment, Samson also found that habitat for the flammulated owl is abundant and widespread in the Northern Region. Samson cited scientific findings by McCallum (1994) that flammulated owl is perhaps the most common raptor in montane forests of the western United States. Samson's assessment found that virtually every researcher working with flammulated owls suggested that fire suppression had been a negative influence on habitat (Groves et al 1997, Linkhart 2001). Samson concluded that reintroduction of fire and mechanical removal of understory trees over large areas could serve to restore habitat at threat from encroachment of shade tolerant trees.

For the pileated woodpecker, Samson found that habitat is also abundant and well distributed, and that current post-fire and insect outbreaks may benefit the species. Samson reported that timber harvest may affect the availability of nest trees and winter foraging habitat, however that current levels of timber management are insignificant given other changes on the landscape due to fire suppression (Gallant *et al* 2003, Hessburn and Agee 2003).

Samson (2006a) assessed vegetation data collected in known locations where goshawks, flammulated owl, and pileated woodpecker have occurred in Region 1 to identify a range of habitat conditions applicable for each species by ecological province. Appendix 9, Table 1 displays the ranges of attributes, calculated using Region 1 Vegetation Council algorithms (Berglund *et al* 2005). Appendix 9, Table 1 also displays the range of conditions for each species compared to the range of vegetation attributes found in old growth defined by Green et al. (1992). This data shows that each species nests and/or forages in a broad range of vegetative conditions that may include some old growth stands as well as other vegetation attributes and size classes not included in old growth.

Northern Goshawk

The Northern Goshawk has long been considered an "indicator species" for old growth coniferous forests.. In the U.S. Fish and Wildlife Service's *"The Northern Goshawk Status Review,"* a team of research scientists found that the goshawk typically uses mature forests or larger trees for nesting habitat; however, it is considered a forest habitat generalist at larger spatial scales with no evidence that the species is dependent on large, unbroken tracts of "old growth" or even mature forest or specifically selects for "old-growth" forest. (USDI-FWS 1998, Federal Register 63: 35183, June 29, 1998). Size of the typical home range or foraging area for the goshawk is large, 1,409 to 8,649 acres, and may vary depending on a number of factors such as age and sex of the bird, prey abundance, prey availability, and local habitat conditions (Reynolds et al. 1992, Hargis et al. 1994, Kennedy et al. 1994, Wisdom et al. 1999, Kennedy 2003, Squires and Kennedy 2006).

Figure 1. Female northern goshawk (3 years of age) perched in a Douglas-fir tree (approximately 10in in diameter), Pattee Canyon, Missoula, Montana (photo by M. Burcham).

Goshawks (Figure 1) nest in a variety of forest types (Figures 2 through 4). In general, the nest area vegetation is described by a comparatively narrower range of structural characteristics than the surrounding post fledging area (PFA) and foraging area. Nest areas are typically forests dominated by trees > 7 inches in diameter, contain relatively dense canopies (50 to 90%), and have open understories (Squires and Reynolds 1997; USDI Fish and Wildlife Service 1998; Samson 2006a, Squires and Kennedy 2006, Brewer et al. 2007). A survey of 316 nests in northern Idaho, Montana, western North Dakota, and northwestern South Dakota indicated that 60% of nest sites were in the Douglas-fir forest type, followed in order of prevalence by lodgepole pine (16%), ponderosa pine (14%), hemlock/spruce (4%), and small percentages of hardwood and mixed conifer types (USFWS 1998).

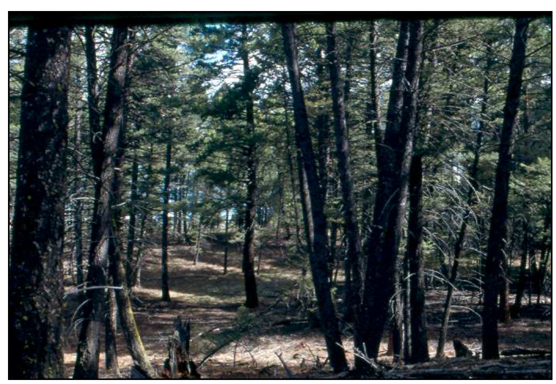

Figure 2. Occupied goshawk nest stand, Flint Mountains, east of Missoula, MT. Douglas-fir dominant, average tree diameter = 17in.; canopy cover 78%. Picture taken standing under the nest tree facing northwest. (Photo by L. Brewer).

Average size of the nest area varies based on local habitat conditions and has been reported as ranging from 1 to 148 acres. In west central

Montana, the average nest area was approximately 40 acres in size, surrounded by a mix of younger forest and non-forested openings (Clough 2000). In Region 1, Canfield (2006) found similar results in an assessment of the vegetation patterns in 1700-acre sampling units where goshawks were detected during a 2005 random survey across all of Region 1 forests (Kowalski 2005). In the northwestern United States, McGrath et al. (2003) showed *"the goshawk's reliance on specific habitat conditions for nesting decreases as distance from the nest increases."* They found the composition of vegetative types, including tree canopy cover and size class distributions located outside the nest area blend into the surrounding landscape such that, no difference in habitat composition in occupied versus random foraging areas can be detected.

Figure 3. Great gray owl chicks in a goshawk nest tree that had been occupied by a nesting goshawk the previous year, Flint Mountains, east of Missoula, MT. Lodgepole pine/Douglas-fir (mixed conifer) with aspen inclusions, average tree diameter = 11in.; canopy cover 75%. Picture taken facing northwest. (Photo by L.Brewer)

Goshawks hunt in a diverse array of cover types from open steppe to dense forests (USFWS 1998). Although conducted in northern Arizona, recent research has indicated that goshawks do not select foraging sites based on prey abundance, rather they select foraging sites that have higher canopy closure, greater total tree density, and greater density of large trees (Beier and Drennan 1997). These results support the hypothesis that goshawks are adapted to hunting in moderately dense, mature forests and that prey availability is more important than prey density in habitat selection (Ibid.). Forest stands can generally be considered suitable foraging habitat if a stand is open enough to allow a goshawk unimpeded flight through the understory). Goshawk foraging areas are heterogeneous and may include mature forest (> 40% canopy cover), as well as a mix of other forest (< 40% canopy cover) and non-forest

Figure 4. Goshawk nest in a larch/Douglas-fir (mixed conifer) stand, west of Missoula, MT. (Photo by D. Wrobleski).

components (i.e., sagebrush, grasslands, lowland riparian, and agriculture) (Reynolds et al. 1992; Reynolds 1994; Younk and Bechard 1994; Patla et al. 1997, McGrath et al. 2003).

Flammulated Owl

Little was known of the distribution and habitat needs of flammulated owl in Montana until recent years. Flammulated Owls were widely considered rare in the American West until the use of callback surveys became a common tool in the past several decades (McCallum 1994). In Montana, the first nesting record was not documented until 1986 (Holt, et al. 1987), and Flammulated Owls were not found regularly until the 1990s. In 1995, the Lolo National Forest began monitoring for owls on a regular basis (unpubl. Data). In 1996, Wright (1996) was especially successful in locating birds on the Bitteroot, Beaverhead-Deerlodge, and Lolo National Forests.. Until that time, most Montana breeding records were from west of the continental divide (Montana Bird Distribution Committee 1996). In 2005, a random survey for owls across Region 1 found the species is relatively abundant and well distributed (Cilimburg 2005).

In the Northern Rockies, including the Lolo National Forest, flammulated owls have been found primarily in low to mid-elevations in drier habitats comprised of shade intolerant ponderosa pine, and ponderosa pine/Douglas-fir with low to moderate canopy cover (> 40% in ponderosa pine, >70% in ponderosa pine/Douglas-fir), a larger tree component (>14.9 inches diameter) and snags (McCallum 1994, Wright 1996, and Groves et al. 1997). (Figure 5).

Figure 5. Old growth ponderosa pine with Douglas-fir patches in the understory. Flammulated owl acoustical survey response site, Wilkes Divide, north of Missoula, MT

Territory size, based on radio telemetry studies done elsewhere, average from 27 to 45 acres, with four or five one-acre patches of openings located near the nest site appearing important for foraging (Linkhart et al. 1998). Flammulated owls are found where there is an abundance of nocturnal arthropod prey (Figure 6), specifically Noctuids, which are large, cold hardy nocturnal moths that appear more abundant in spring and summer than other arthropods (McCallum 1994). The owls feeds almost exclusively on these moths which are more abundant in drier, open ponderosa pine/Douglas fir forests than other western conifer forest types (Reynolds and Linkhart 1987). Owls foraged on arthropods along the forest/grassland edge, as well as in ponderosa pine/Douglas-fir forests of low or moderate density. Prey items were 2.7 times as numerous in ponderosa pine/Douglas-fir forest, and 8.7 times more abundant in grasslands than in nearby mixed conifer stands (*Ibid*.).

Figure 6. Flammulated owl sitting on a branch of a large ponderosa pine tree with a Noctuid moth in its beak (photo taken from LNF photo library). The Flammulated owl is the only migratory owl species found in the northwestern U.S., arriving from Mexico, Central, and South America in Montana in April to breed, returning south in late fall to winter.

In Montana, an important scientific study that included portions of the Lolo found that these owls occupy landscapes that have a greater proportion of xeric (dry) ponderosa pine/Douglas-fir stands with low canopy cover and are absent from landscapes with high canopy cover (Wright 1996, Wright et al. 1997). Linkhart (2001) concluded the association of flammulated owl productivity to open-grown forests with larger diameter trees suggests that the species is adapted to forests that were historically maintained by frequent fire. A comparison of available ponderosa pine on the Lolo National Forest from 1938-42 to what exists today, shows that ponderosa pine in all size classes has declined by about 2%, whereas Douglas-fir (a more shade tolerant species) has increased by 12 to 14% (Samson 2006a), indicating an increase in habitat for the species. A review of FIA plot data (n=3700) in Montana, showed that forest conditions within these drier forested habitat types that typically received frequent fires of low to mixed-severity are considered “at moderate to high risk” of loss from stand replacement fires from increased densities of shade tolerant trees such as Douglas-fir (Fiedler 2003).

Winter range records for this species are sparse; probable winter distribution for this insectivorous, migratory owl stretches from the southwestern United States to Central America.

Flammulated Owls nest primarily in cavities excavated by woodpeckers (including the pileated woodpecker) in large trees and snags. In northeastern Oregon, stands of large-diameter (>20 inches dbh) ponderosa pine and Douglas-fir or grand fir with ponderosa pine in the overstory were identified as nesting habitat (Bull and Anderson 1978, Bull et al. 1990). Preferred nest sites were old woodpecker holes created by Pileated Woodpeckers or northern flickers. Similarly, Goggans (1986) described nesting habitat in eastern Oregon as stands of ponderosa pine/Douglas-fir, 30-50 cm DBH, with less than 50% canopy closure.

A crucial aspect of roosting habitat appear to be tree density; owls roosted in mixed conifer patches in close proximity to the nest site, and avoided pure ponderosa stands. In Colorado, Reynolds and Linkhart (1987, 1992) found a strong association between Flammulated Owls and old-growth ponderosa pine/Douglas-fir habitat, noting that such forests were used more than expected for nesting, foraging, and singing. They speculate that the presence of cavities and snags, the abundance of arthropods, and an open stand structure suitable for foraging may be factors in this preference. Males were also observed calling from pockets of dense foliage in what were otherwise open stands. Thickets of dense foliage were also used for calling and roosting in a study in New Mexico (McCallum and Gehlbach 1988).

At the northern edge of the owl's range in British Columbia, Howie and Ritcey (1987) identified mature/old growth (> 100 year-old) Douglas-fir and Douglas-fir/ponderosa pine stands as nesting habitat, finding that owl densities were highest in stands 140-200+ years old. Owls were restricted to open stands with multilayered canopies and an abundance of large, well-spaced trees interspersed with grassy openings up to 5 acres in size. Regenerating thickets within stands were used for roosting. Although they found a clearer association with mature/old-growth Douglas-fir than with ponderosa pine, they stated that *"...the open nature of the fir forests coupled with natural or artificial openings created by logging probably resembles the physical structure of preferred forests in the southern portion of the owl's range."* In Central Idaho, territorial owls occupied relatively open, multi-storied Douglas-fir, ponderosa pine, and mixed conifer stands with some mature trees usually present (Atkinson and Atkinson 1990). Territories were often near more open areas, including old burns, grassy hillsides, natural clearings, or clearcuts. Atkinson and Atkinson (1990) also noted a clumped distribution of territorial males, along with unoccupied areas of apparently optimal habitat. A recent study conducted by Wright (1996) in Montana’s Bitterroot Valley indicated that Flammulated Owls select for appropriate microhabitat features (large trees and large snags), but only within an appropriate landscape context. The owls were not present unless the larger landscape consisted of low-canopy-ponderosa pine/Douglas-fir forests, and then only where grassland or xeric shrubland openings were present at a home-range scale. Flammulated Owls were not found on otherwise suitable sites when the surrounding landscape was predominantly moister coniferous forest types, and they were less abundant in ponderosa pine/Douglas-fir landscapes that were heavily logged (even-aged cuts).

At the home-range level, mean territory sizes reported in the literature were 35 acres by Reynolds and Linkhart in Colorado (1987) and 25 acres by Goggans in Idaho (1986). Flammulated Owls often demonstrate a clustered distribution across the landscape with large unoccupied spaces in between (Howie and Ritcey 1987, Atkinson and Atkinson 1990, Reynolds and Linkhart 1992,Wright et al. 1997). In Montana, 90% of Wright's owl observations were clustered (>3 owls per transect) along only 18% of the study's transects. This is probably a consequence of owls occupying appropriate microhabitat only when the larger area is also suitable (Wright 1996). It has also been speculated that clustering may be a reflection of social requirements, such as mate selection (Winter 1974).

Large snags appear to provide the most important nesting substrate for Flammulated Owls in two Oregon studies (Goggans 1986, Bull et al. 1990), with 85% percent of Goggans' nests located in ponderosa pines. McCallum and Gehlbach (1988) inferred a preference for open, mature vegetation in the nesting vicinity from their comparison of vegetation around occupied and unoccupied cavities. In related findings, McCallum and Gehlbach (1988) and Bull et al. (1990) noted lower shrub densities in front of nest cavity entrances than behind. Flammulated Owls strongly prefer open forest and edge habitat for foraging during late summer, rarely venturing into dense forest stands to hunt (McCallum 1994). Grassland edge habitat may have special foraging importance. Goggans (1986) found edge habitat to be used disproportionately for foraging, especially in late-summer pounce-dropping by adults and fledglings. Grassland edge habitat also contained three times the number of prey items than the adjacent open forest areas. Habitat types with an open forest overstory, but a closed, shrubby understory were not occupied by Flammulated Owls in Montana (Wright 1996).

In order to provide suitable foraging habitat throughout the breeding season, Flammulated Owls appear to need both open overstory and understory. Nonetheless, it does appear that Flammulated Owls use, and perhaps need, a limited amount of clustered, dense vegetation in their breeding territory. Dense trees were used preferentially for roosting and calling in studies in Idaho and Colorado (Goggans 1986, Reynoldsand Linkhart 1987). Roost sites were located in close proximity to nests (65-330 ft; <65 ft pre-fledging). Thick regeneration was used for roosting in British Columbia (Howie and Ritcey), and was commonly available on sites in New Mexico (McCallum and Gehlbach 1988).

Pileated Woodpecker

Two aspects of pileated woodpecker ecology govern their habitat selection—nesting and winter foraging. The pileated excavates a new nest cavity each year (Bull and Jackson 1995), often in trees (live, but most often dead) that have been softened by fungal decay (Bull 1987, McClelland and McClelland 1999). In winter, pileated woodpeckers excavate relatively sound wood around the base of trees in search of carpenter ants (Flemming et al. 1999). In the Northern Rocky Mountains, pileated woodpeckers use a variety of forest types, including mature cottonwood bottoms (Figure 7), ponderosa pine (used by flammulated owls), western larch stands, mixed conifer, and cedar-hemlock (Hutto 1995, McClelland and McClelland 1999). Canopy cover does not appear important, that is any stand

Figure 7. Pileated woodpecker in a cottonwood tree in winter.

that can be classified with forest cover (>10%) will be used for nesting or foraging (Bonar 2001; Samson 2006a); with any number of available nest trees at least 15 inches in diameter (McClelland and McClelland 1999, Bonar 2001, Aubrey and Raley 2002, Samson 2006a), and some amount of winter foraging trees at least 10 inches in diameter (Samson 2006a). No evidence exists that the pileated woodpecker is dependent on large, unbroken tracts of “old growth” or mature forest or specifically selects for "old-growth" forest. Based on birds fitted with radio collars in other parts of the country, territory size seems to vary considerably, ranging from a mean of 213 ± 78 acres (Renkin and Wiggins 1989) to 1181 ± 541 acres (Bull and Holthausen 1993).

These woodpeckers are widely distributed in forests of the eastern U.S., but are confined in the west to Washington, Oregon, northern California, and the northern Rocky Mountains. Their absence in the central and southern Rocky Mountains is due to a lack of dense, highly productive forests with rapid maturation and decay (Bock and Lepthien 1975, Schroeder 1981). In Montana, the species is restricted to forested areas west of the Continental Divide (Montana Bird Distribution Committee 1996, Bull and Jackson 1995), eastward to the edge of large trees on the east slope of the Rockies (McClelland 1977). In three years of data from the Northern Region Landbird Monitoring Program, the species was detected at only 19 points east of the Divide. The Pileated woodpecker is nonmigratory, but may move to lower elevations in winter.

The Pileated woodpecker inhabits both coniferous and deciduous forests, but is restricted to areas containing mature, dense, productive stands (Bock and Lepthien 1975). It is a strong old growth associate in Oregon Coast Range (Carey et al. 1991), where all 33 foraging observations were in trees greater than 16 inch dbh. Weak old-growth associate in Oregon Cascades (Huff and Raley 1991), but in the Washington Cascades (Manuwal 1991), abundance was similar in young, mature and old growth, although it should be noted that all stands were naturally regenerated and even young stands had large residual snags. In western Washington, most radio-telemetry locations were in old growth (Aubry and Raley 1993). Among nine areas studied by Bull and Holthausen (1993), the density of snags > 20 inches dbh was the best predictor of density of this species (1-7 pairs). Pileated Woodpecker abundance increased as the amount of forests with no logging, >60% canopy closure, and old growth increased. Within home ranges, all birds used stands with old growth, grand fir, no logging, and >60% canopy closure more than expected based on availability. In western Oregon, radio-collared individuals used all age classes of conifer forests as well as deciduous riparian vegetation, with forests < 40 years used significantly less often. All nests (n=18) were in conifer forest > 70 years old (Mellen et al. 1992).

The Pileated is a very large woodpecker with a large home range. Bull and Holthausen (1993) found home ranges to be 793-1557 acres (mean= 1006 acres, 899 acres forested) for 7 pairs, and 494-3610 acres (mean = 1475 acres, 1334 acres forested) for 9 unmated birds. Mellen *et al* (1992) measured 660-2609 acres (mean = 1181 acres; with 136-1001 acres of forest > 70 yrs) in western Oregon. The Pileated woodpecker forages on or near ground, on fallen logs or low on snags, consuming primarily carpenter ants and beetle larvae. Bull and Holthausen (1993) recorded 38% of foraging observations on logs, 38% on snags, 18% on live trees, and 6% on stumps. This primary cavity nester, excavates nest and roost holes in large snags that are later used by many other species. The Pileated Woodpecker requires large snags for nesting and downed logs for foraging. All but one of 105 nest trees in northeastern Oregon were in dead trees (Bull 1987). Average dbh was 33 inches. Ponderosa pine and western larch was favored over Douglas-fir and grand fir. They preferred snags with less bark, but did not require decayed wood. Fifty-five percent of nest trees had broken-off tops. In western Montana, 13 of 22 nests were in western larch (ponderosa pine was rare in the study area) (McClelland 1977). Average dbh was 31 inches (range 15 - 43 inches). Of 18 nests in western Oregon (Mellen et al. 1992), average dbh was 28 inches (range 16 – 54 inches).

Maintaining or Restoring Habitat Conditions

Conclusive evidence of the appropriateness of using silvicultural treatments to maintain or restore particular vegetative structures for old growth associates is limited.

In 2002, Hejl *et al* examined the relationship of human induced changes to habitat conditions of the Rocky Mountains. By examining changes in forest fragmentation and structure from timber harvest and fire suppression, they induced that while habitat has been fragmented in the Northern Rockies, it may not be affecting as many species as in other parts of North America. Their greatest concern was for species that are associated with habitats that have changed the most, and point toward the once heterogeneous stands of ponderosa pine and western larch that have become homogeneous expanses of mid-successional mature forest as a result of fire suppression.

In Brewer et al's (2007) overview of the Northern Goshawk in the Northern Region, the authors summarize that forest management can either degrade or enhance goshawk habitat, but that it is the primary activity that impacts goshawk populations. Like Hejl (2002), they conclude that if conducted, silvicultural and prescribed fire treatments should be consistent with natural forest patterns and fire regimes.

For the Northern Goshawk, Squires and Kennedy (2006) explained that higher tree densities and a decrease in understory vegetation has altered or degraded habitat in the lower elevation warm-dry ponderosa pine ecosystems. However, in the cooler subalpine forests, fire suppression may have had little effect on goshawk based on the historic fire regimes of these areas. Use of silvicultural treatments which include thinning from below before prescribed fire is applied may create stand conditions that are favorable for goshawk nesting and foraging (Reynolds et al 1992, Squires and Kennedy 2006, Brewer et al 2007).

Wright et al's (1997) Flammulated Owl study on the Bitterroot and Lolo National Forests, found the bird to be present in approximately half of the selectively-logged microhabitat plots in their study area. Occupied stands contained large residual trees and snags. Haenyager et al (1979) and Bloom (1983) reported similar findings. Howie and Ricey (1987) also observed owl use of mature and old stands of Douglas-fire that had been selectively harvested 2-3 decades prior to their surveys in British Columbia. The multi-storied stands they examined contained 35-65 percent overstory canopy closure composed of Douglas-fir and ponderosa pine, a Douglas-fir understory, and a sparse shrub layer. Occupied plots in selectively-logged stands in Wright et al's study were found in stands that had been harvested less intensively, leaving larger trees and snags intact.

In 1995, Bull et al found that pileated woodpeckers continued (albeit at a lower level) to use stands treated by selection harvest which maintained large, old-structure components and regenerated the site with early seral species. In a later study, Bull et al (2005) also found that fuel reduction treatments retained foraging habitat for the pileated woodpecker. In similar vegetation types to those on portions of the Lolo, Bull et al's 2005 study compared mechanical removal only with mechanical removal followed by prescribed burning treatments. They found that their control and mechanical removal stands provided significantly more foraging habitat than stands treated with prescribed burning. The higher incidence of ants in the control and mechanical removal treatments explained the greater use by woodpeckers. Although foraging by pileated woodpecker in mechanical removal treatments was not as common as in the control treatments, there was significantly more foraging than in the prescribed burn treatments. The removal of standing trees alone did not prevent pileated woodpeckers from using the stands. The lower occurrence of ants in logs, snags, and stumps in the prescribed burn treatment suggested that burning either directly eliminated the ants or rendered the habitat unsuitable for ants. In the burn treatment, the logs in the advanced decay class would have likely been consumed.

In Young and Hutto's (2002) three year exploration of the effects of partial-cut timber harvesting on over 85 bird species, they found greater numbers of birds (including the pileated woodpecker) in partially cut stands than in uncut stands. They concluded that the land use effects revealed in their study suggest that regional bird populations may be strongly affected when acreages of partial-cut forestry are summed across the landscape.